

2.2 Gas Exchange WJEC Questions

1. Explain the role of each of the following in the opening mechanism of the stomata.

(a) (i) Potassium ions. [2]

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(ii) The thickness of guard cell walls. [2]

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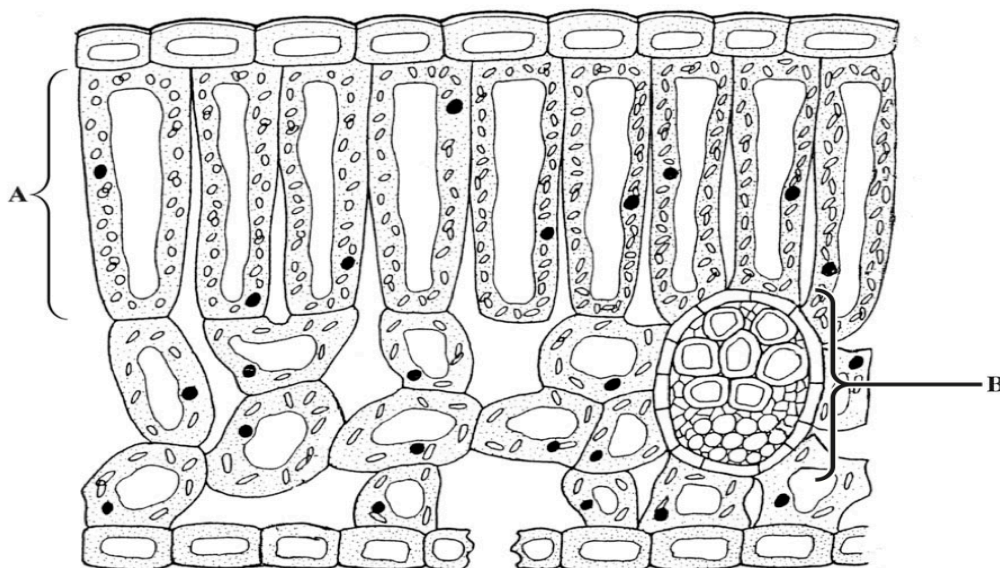
(b) State **two** environmental factors that affect the opening and closing of stomata. [2]

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(Total 6 marks)

2. (a) The diagram below shows a section of a leaf.



Identify the structures **A** and **B** and state the function of each. [4]

A Name

Function

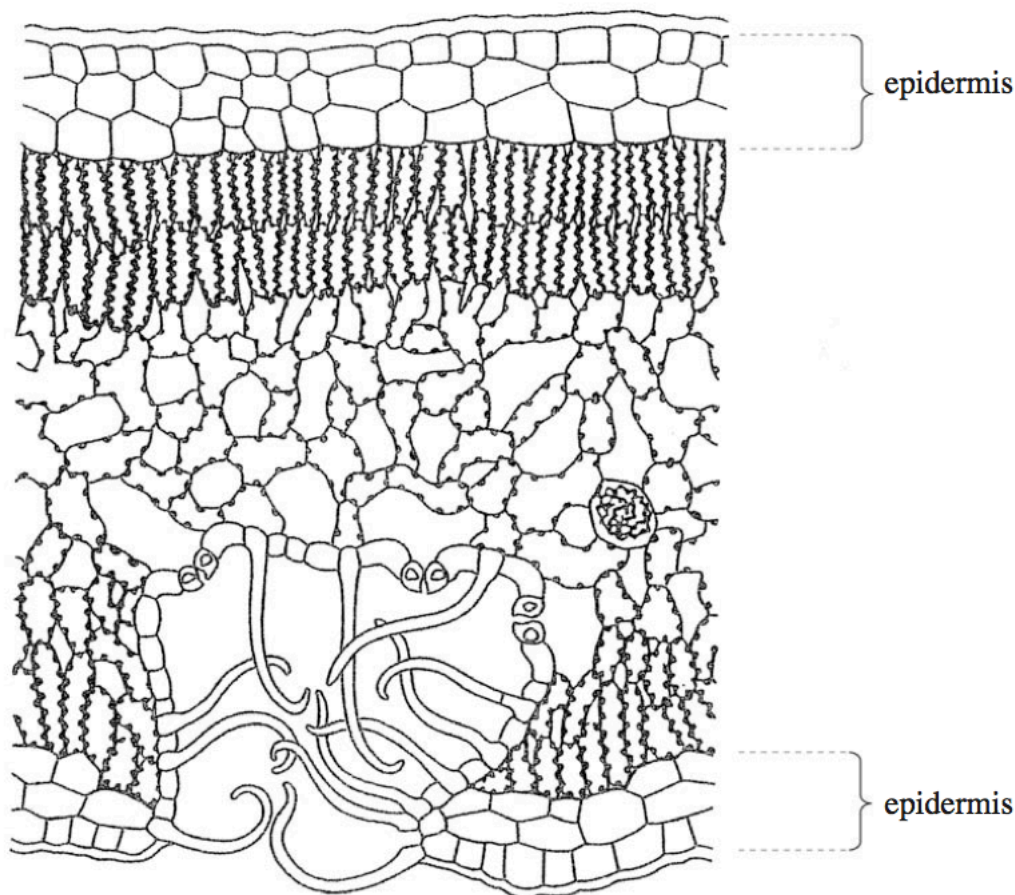
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B Name

Function

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(b) The diagram below shows a leaf taken from a plant that lives in a hot and dry environment.



(i) State the name given to the types of plant that live in hot, dry environments. [1]

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(ii) Use label lines marked **A**, **B** and **C** to indicate on the diagram **three** different features of the leaf that enables the plant to live in hot, dry conditions. [3]

(iii) Explain how each of the features, which you have indicated in (ii), helps the plant to live in its environment. [3]

A

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B

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C

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(Total 11 marks)

3.

- (a) All living organisms exchange gases with the environment. Respiratory surfaces in all organisms have a very large surface area. Give **three other** properties of respiratory surfaces common to **all** organisms. [3]

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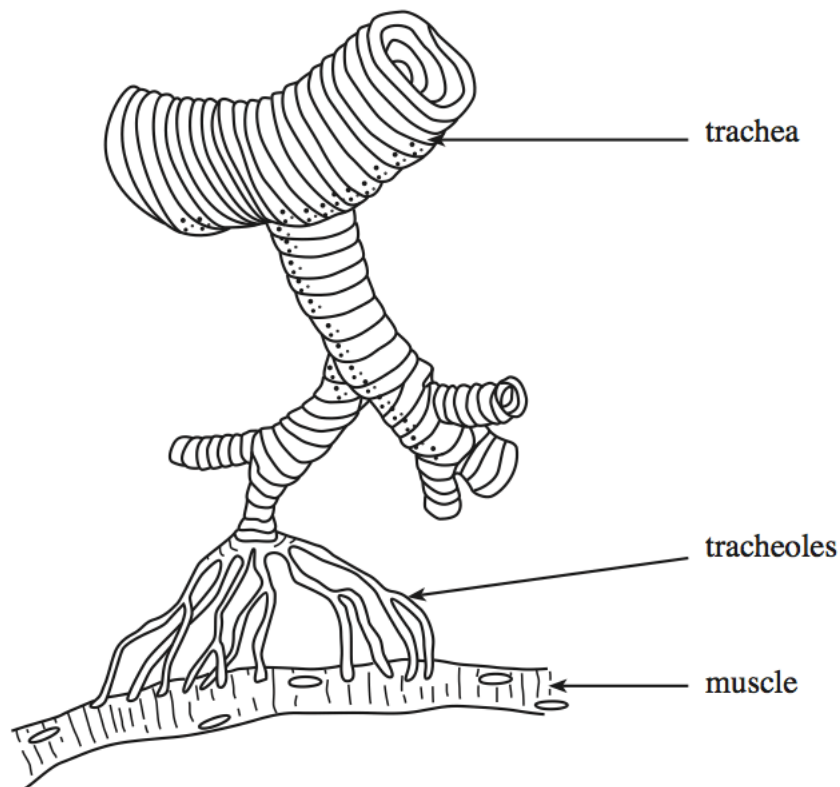
2

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3

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- (b) Insects use a tracheal system for gas exchange, as shown below.



- (i) On the diagram use a line **labelled R** to show the respiratory surface. [1]

- (ii) State **two** advantages of using a tracheal system for gas exchange. [2]

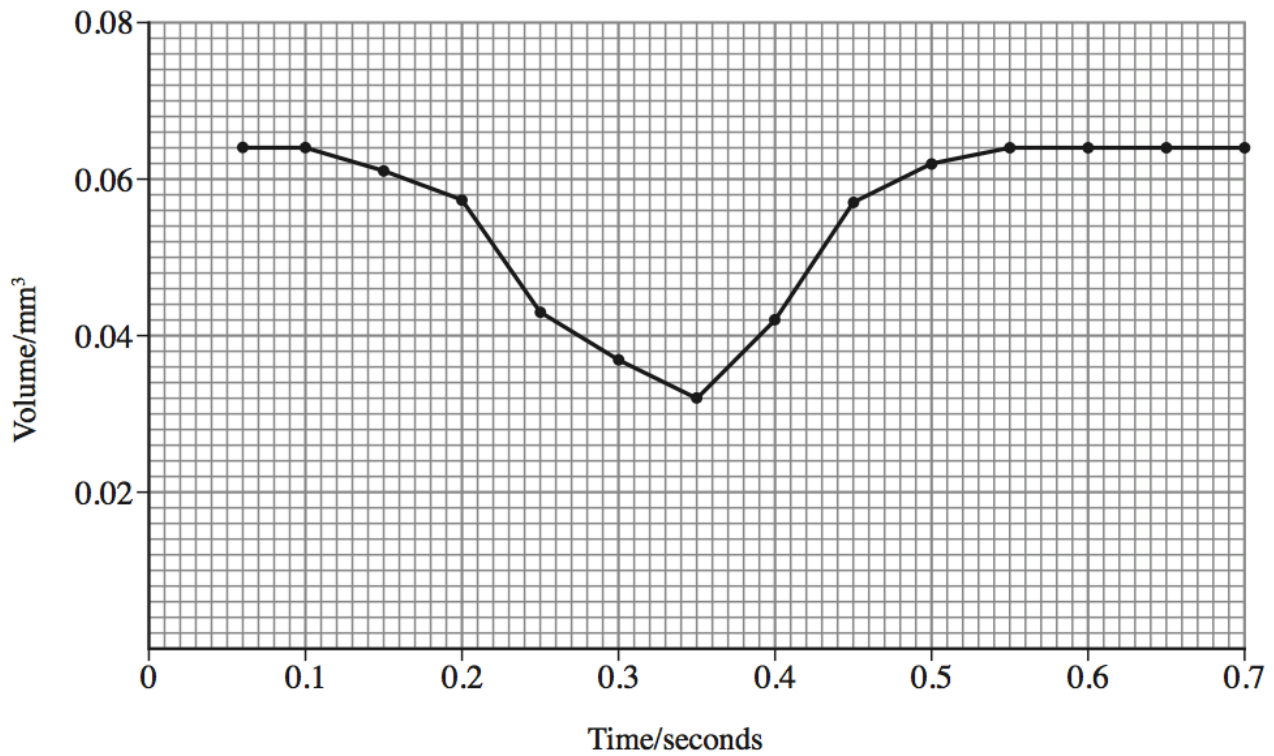
1

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2

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- (iii) The graph shows the volume change in the main trachea in the anterior thorax and head of a beetle.



Calculate the percentage (%) volume change. Show your working.

[2]

Answer

- (c) Describe and explain the process of inspiration in a mammal.

[4]

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(d) Gas exchange in fish takes place across a special surface, the gill.

- (i) State the difficulties aquatic organisms face, compared to terrestrial organisms, in obtaining oxygen from water. [2]

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- (ii) In cartilaginous fish, such as sharks, a parallel flow system operates in the gills and in bony fish such as Mackerel a counter current flow system is found. Explain what is meant by the terms *parallel flow* and *counter current flow* and state why the counter current system is more efficient. [3]

Parallel flow

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Counter current flow

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Reason counter current flow is more efficient

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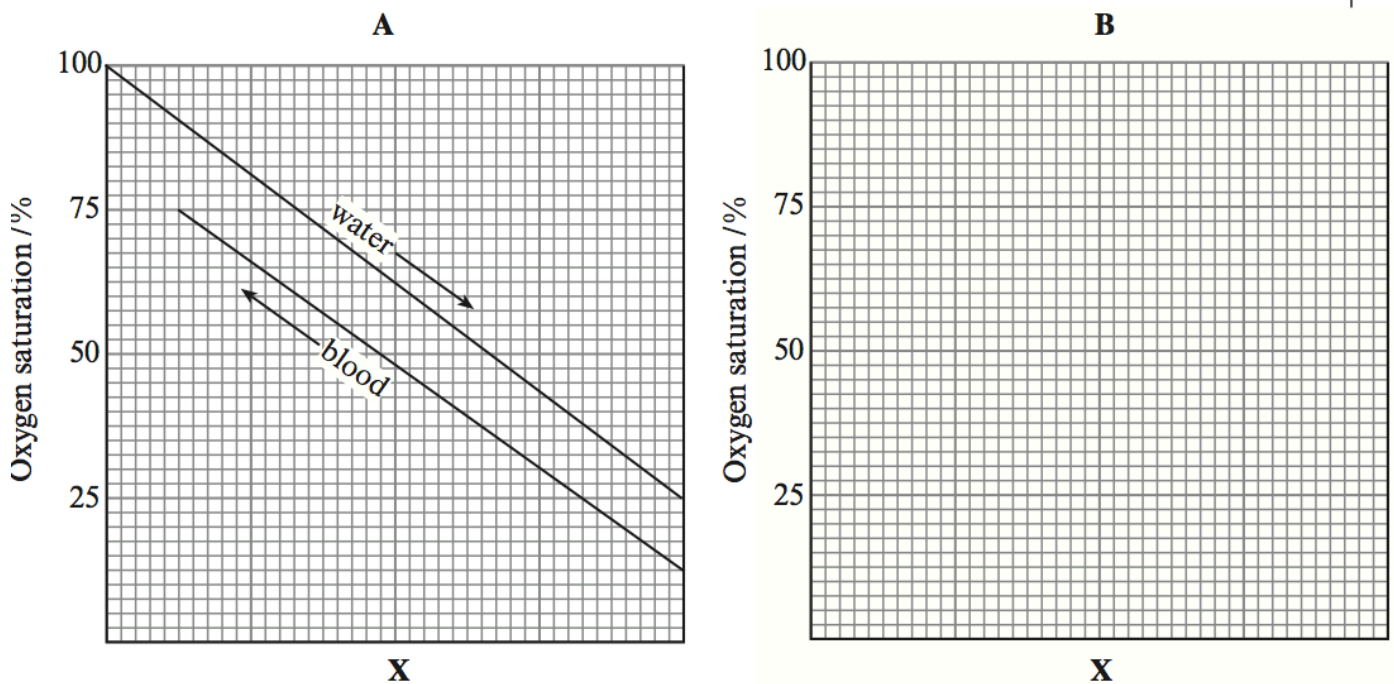
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(Total 17 marks)

4. (a) Name **three** structural features of fish gills which make them efficient gaseous exchange organs. [3]

1.
2.
3.

- (b) Diagram A below illustrates counter current flow in a cod.



In shark gills there is a parallel flow system supplying oxygen.
On diagram B draw a graph to show oxygen uptake in the shark.
(Assume that the flow rates are the same in both cases.) [3]

- (c) What is represented by the label X on the horizontal axis in the diagrams? [1]

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- (d) Explain the advantages to the fish with flow A compared to a fish with flow B. [2]

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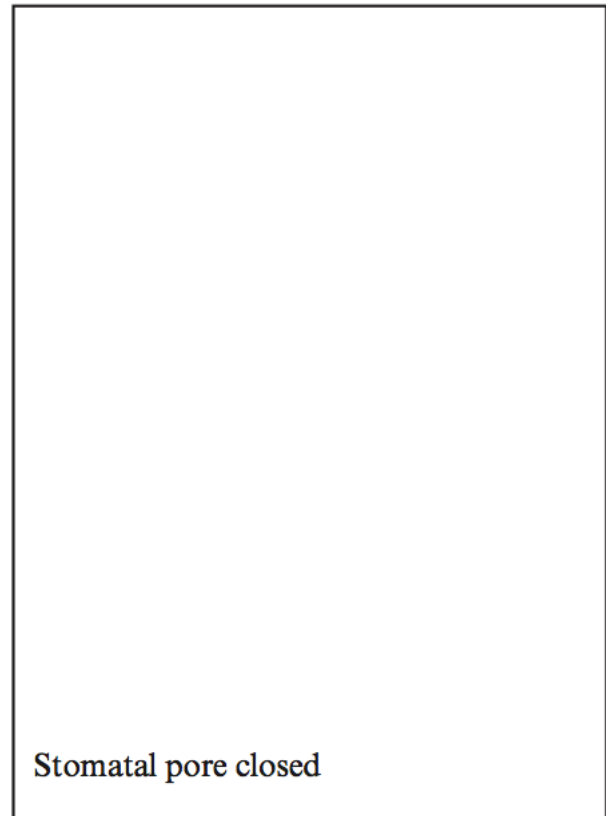
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5.

- (a) (i) Draw two diagrams to show the shape and relative thickness of the cell walls of guard cells in stomata when open and closed. [2]



- (ii) What organelles are present in guard cells but not in the other epidermal cells of a leaf? [1]

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- (b) What is the advantage of stomata opening during the daytime and closing at night? [2]

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- (c) Explain the mechanism by which light causes the opening of stomatal pores. [4]

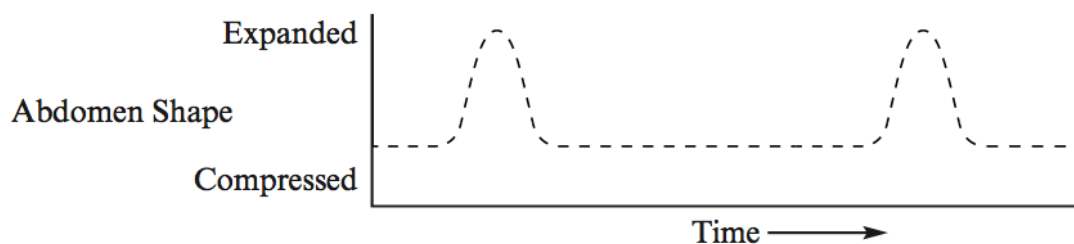
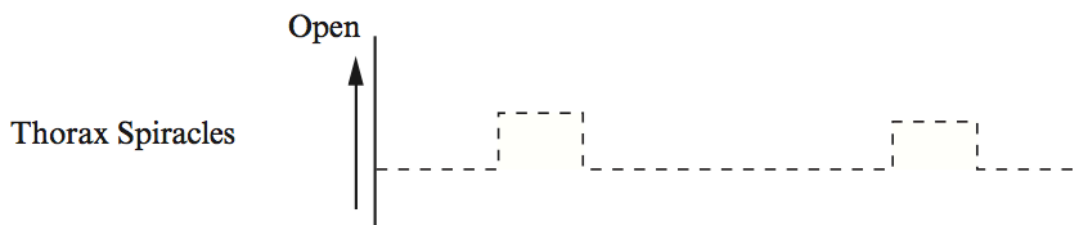
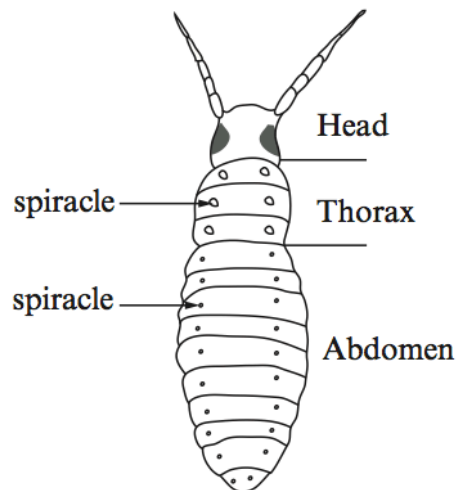
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(Total 9 marks)

6.

The diagram represents the pattern of spiracles of an insect (legs and wings removed). The spiracles are openings into the continuous internal tracheal network which carries respiratory gases to and from the tissues. Each spiracle has a valve which can be closed or opened to control the flow of air into the body.

The graphs below the diagram show the opening and closing of the spiracles in the insect at rest and also how regular muscular movements stretch and contract the abdomen.



(a) Compare the relationship between the movements of the thoracic spiracles and those in the abdomen. [2]

(b) (i) Describe, using the graph, how the change in shape of the abdomen is related to spiracle movements. [2]

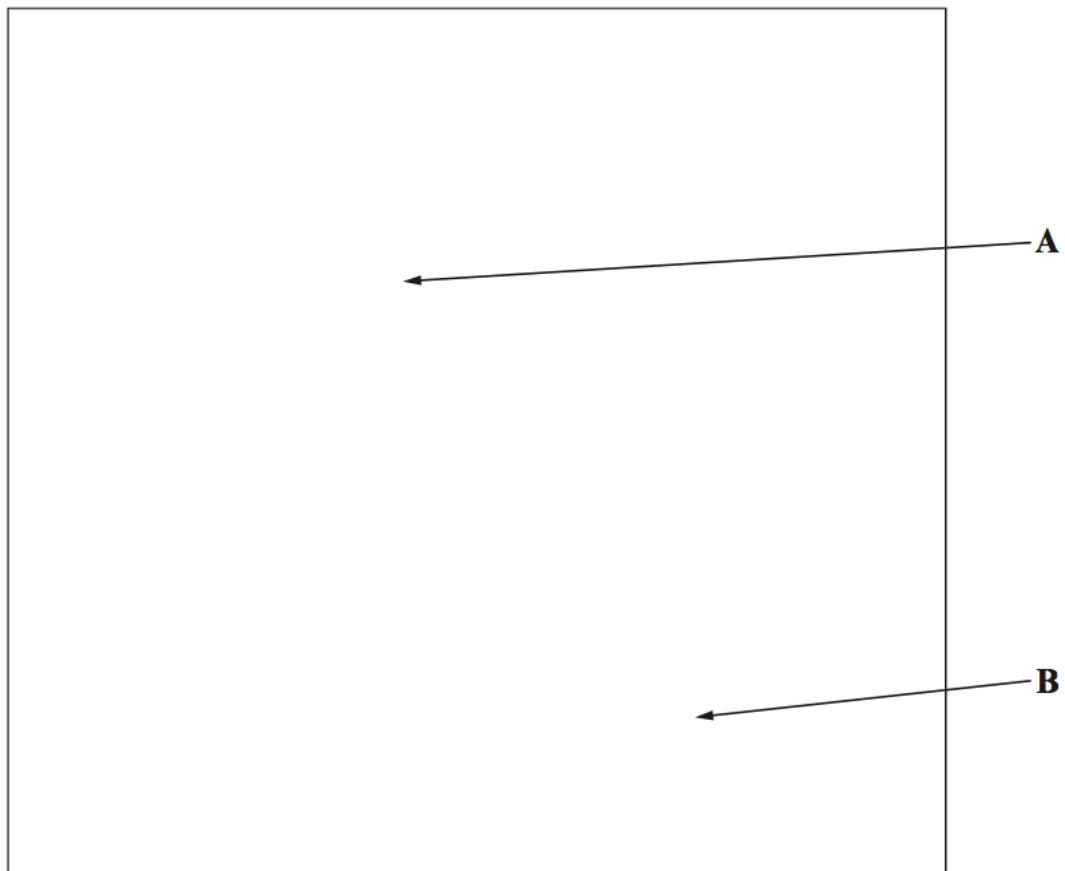
(ii) Suggest how this ventilates the tracheal system. [2]

(c) The graph shows that there are long periods when the spiracles are closed. Explain why this is important for the insect's survival. [1]

(Total 7 marks)

7.

The photograph below shows the surface view of stomata found on the lower surface of *Kalanchoe* (*Kalanchoe* sp.) leaves.



© Image by J. Adds, courtesy of SAPS

(a) Identify cells **A** and **B**. [2]

A

B

(b) Give **two** functions of stomata in leaves. [2]

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(c) Explain how the flow of water into cells A leads to opening of stomatal pores. [4]

(d) When cells A were treated with cyanide the stomatal pores failed to open.
Explain why cyanide is having this effect on these cells. [2]

(Total 10 marks)

8.

In animals gas exchange occurs across respiratory surfaces.

- (a) Describe **three** properties that all respiratory surfaces must possess and explain why they must have them. [3]

Property

Reason

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Property

Reason

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Property

Reason

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- (b) The Flat-headed Frog, *Barbourula kalimantanensis*, is found in fast-flowing mountain streams and is the only known lungless frog.

- (i) Suggest how this frog carries out gas exchange without lungs. [1]

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- (ii) How do the conditions in the mountain stream aid gas exchange? [2]

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- (iii) Give **two** reasons why gills do not function effectively on land. [2]

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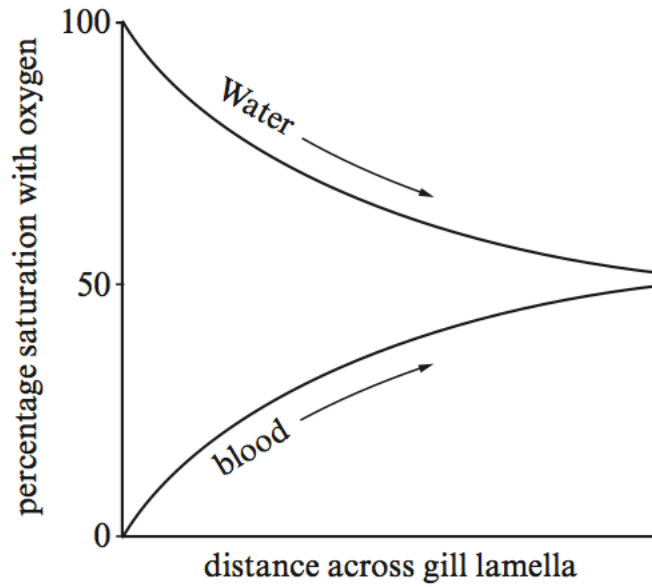
- (c) Define counter-current flow as seen in the gills of bony fish, and explain why counter current flow makes gas exchange more efficient. [3]

9.

- (a) Describe and explain the process of **inspiration** in a mammal. [4]

- (b) (i) Explain how counter current flow works in the gills of bony fish. [4]

The graph below shows another type of flow.



- (ii) Name the type of flow shown in the graph above. [1]

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- (iii) Explain why this is less efficient than counter current flow. [2]

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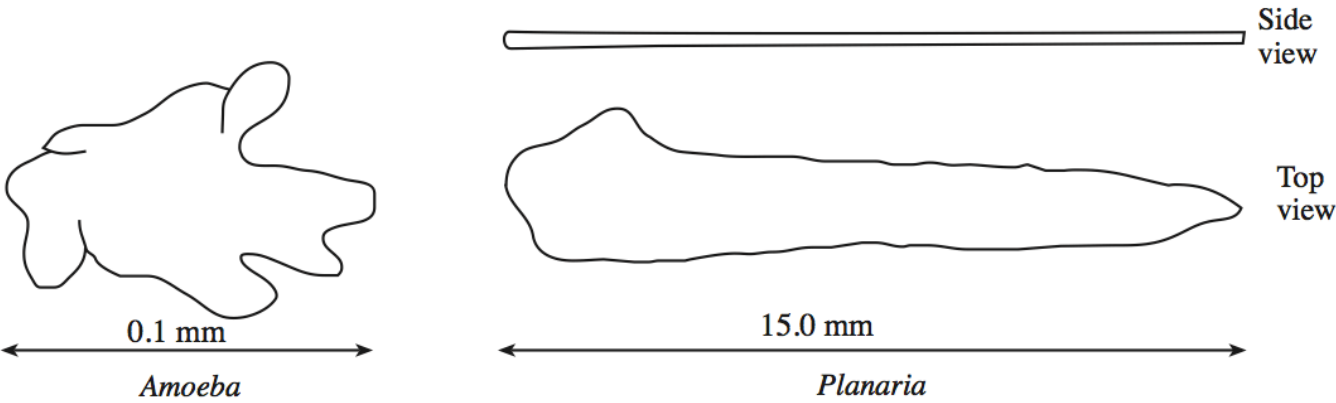
- (c) Suggest why gill filaments/ lamellae would not provide an efficient gas exchange surface on land. [2]

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10.

3. (a) Define the term *diffusion*. [1]

- (b) The drawings illustrate the size and shape of a unicellular organism, *Amoeba* belonging to the Protoctista, and a multicellular, long, thin, flattened worm, *Planaria*.



For each animal, briefly explain why simple diffusion provides an adequate gaseous exchange between the organism and the environment. [2]

Amoeba

Planaria

- (c) The table below shows various dimensions of cubes of animal tissue.

<i>Length of side (cm)</i>	<i>Volume (cm³)</i>	<i>Ratio of Surface area: Volume</i>
1	1	6:1
2	8	3:1

- (i) State, in words, the quantitative relationship between length and the surface area/volume ratio. [1]

- (ii) Large, multicellular organisms such as mammals, need a respiratory exchange surface.

I. Name the respiratory exchange surface in a mammal. [1]

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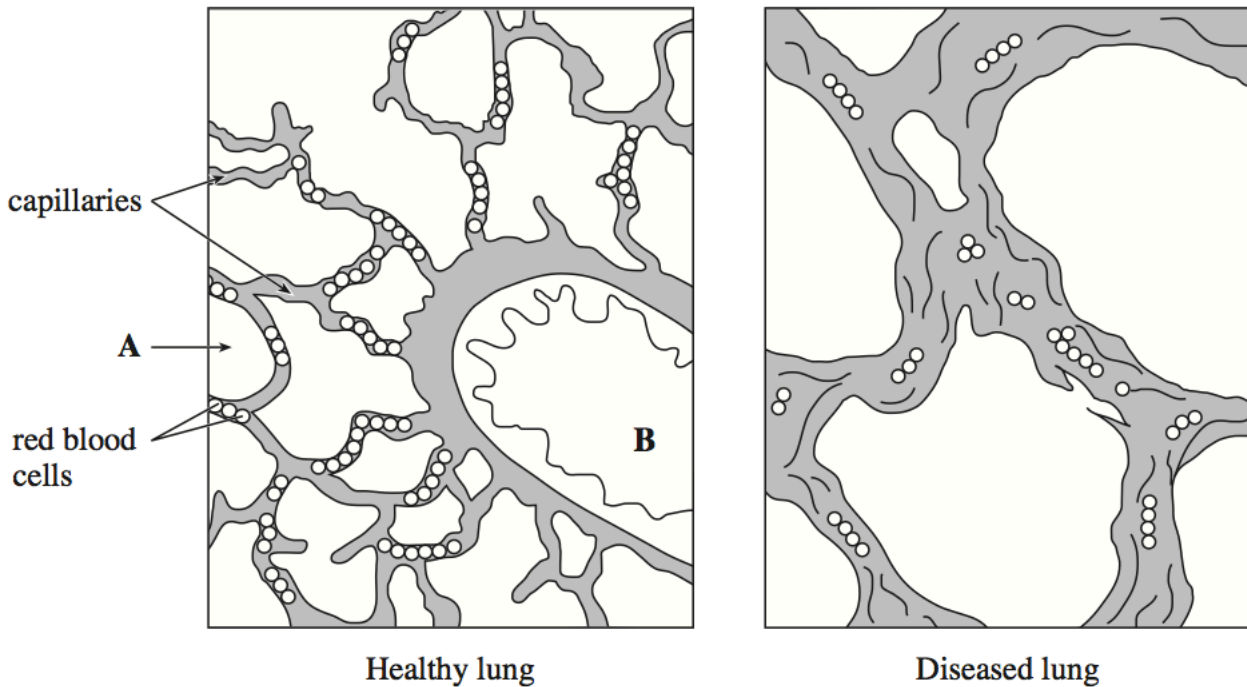
II. With reference to the table, explain the importance of this exchange surface to a mammal. [2]

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(Total 7 marks)

11. *** You are not expected to know a part ii

3. (a) The diagrams show a section through a healthy lung and a section, drawn to the same scale, through a diseased lung.



- (i) Name the structures labelled **A** and **B**.

[2]

A

B

- (ii) State the name of the disease shown in the diagram and explain your reasons for this choice.

[3]

Name of disease

Explanation

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- (iii) Explain the effects that the disease will have on the process of gaseous exchange in the diseased lung.

[2]

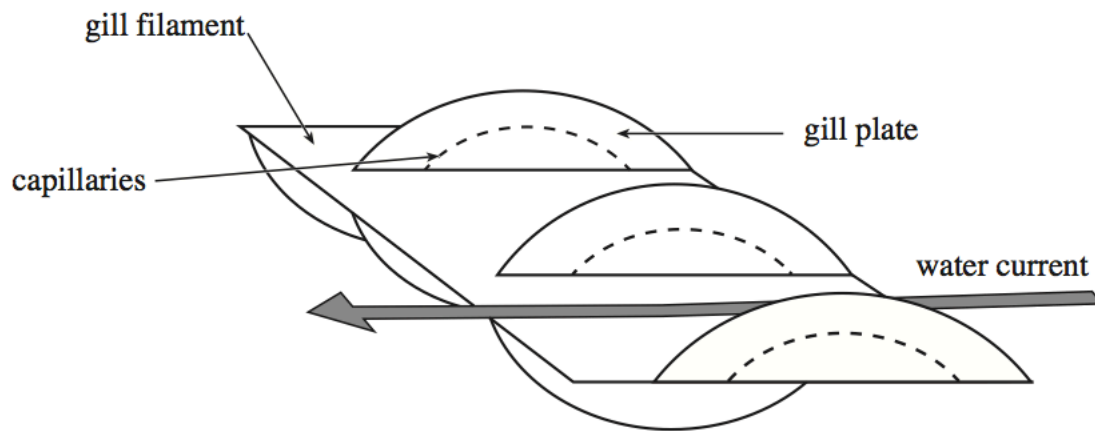
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- (b) The diagram shows the gill filaments of a bony fish. The flow of water across the gill plates is shown.



- (i) Draw an arrow on a capillary to show the direction of blood flow in the gill plate. [1]
- (ii) Use the letter **H**, to indicate on the diagram, an area where there is the highest concentration of oxygen in the blood of the gill plate.
Use the letter **L** to indicate where there is the lowest concentration of oxygen in the water passing over the gill plate. [2]
- (iii) Name this type of flow and explain how it improves the efficiency of oxygen uptake. [2]

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(Total 12 marks)

12.

- (a) Outline the mechanism of ventilation in the lungs by completing the table below.

	<i>Inspiration</i>	<i>Expiration</i>
External intercostal muscles		
Movement of ribcage		
Diaphragm		
Volume of thorax		
Pressure in thorax		
Direction of movement of air		

[6]

13.

(a) Multicellular organisms like fish and mammals have part of their body surface modified to form specialised respiratory surfaces.

(i) Describe **four** properties that the respiratory surfaces of fish and mammals have in common. [2]

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(ii) Give **two** advantages to a mammal of having internal lungs. [2]

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(b) Both fish and mammals have ventilation mechanisms.

(i) Explain the function of ventilation mechanisms. [2]

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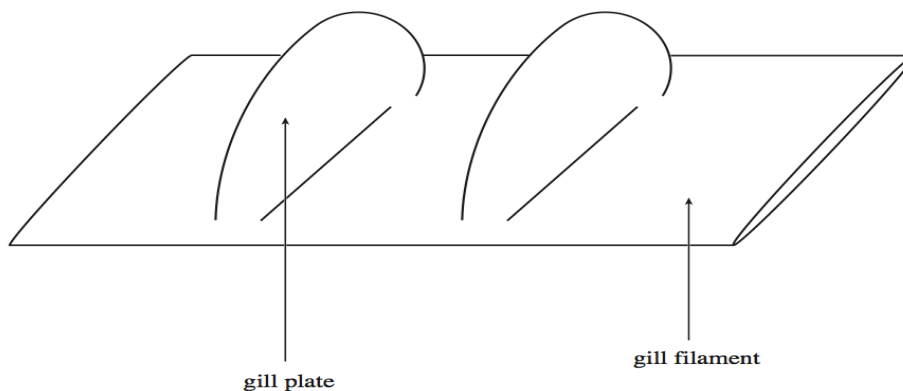
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(ii) Name the muscles which operate the ventilation mechanism in mammals. [2]

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(iii) Use labelled arrows to complete the following diagram to show the relationship between flow of water and flow of blood in the gills of a fish. [2]



(iv) What term is used to describe this relationship? [1]

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(v) Why does this increase the efficiency of the system? [1]

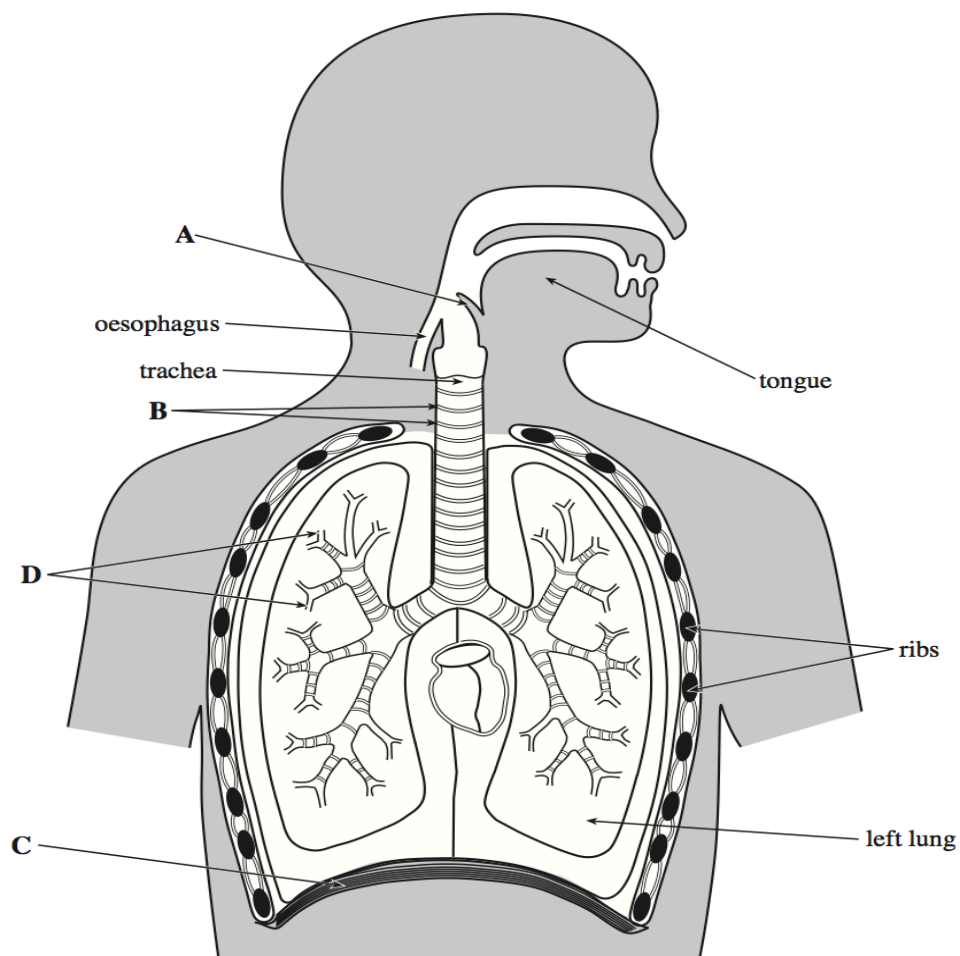
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(Total 12 marks)

14.

The diagram below, shows the head and thorax with the ribs removed.



(a) (i) Name the structures labelled A, B, C, and D.

[4]

A

B

C

D

(ii) Explain the functions of structures A, B and C.

[3]

A

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B

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C

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15.

The surface area and volume of a unicellular organism, such as *Amoeba proteus*, was calculated for organisms each with a different radius. The surface area to volume ratio was determined, as shown in the table below.

<i>Radius of Amoeba proteus/arbitrary units</i>	<i>Surface area of Amoeba proteus/arbitrary units</i>	<i>Volume of Amoeba proteus/arbitrary units</i>	<i>Ratio of surface area to volume</i>
1	12	4	3:1
3	108	108	
4	192	256	

(a) Complete the table above giving the surface area to volume ratios for *Amoeba proteus* cells with radii of 3 and 4 arbitrary units. [2]

(b) With reference to the table, explain why a small unicellular organism, such as *Amoeba proteus* does not require a specialised gaseous exchange surface, but larger multicellular organisms do require an exchange surface. [3]

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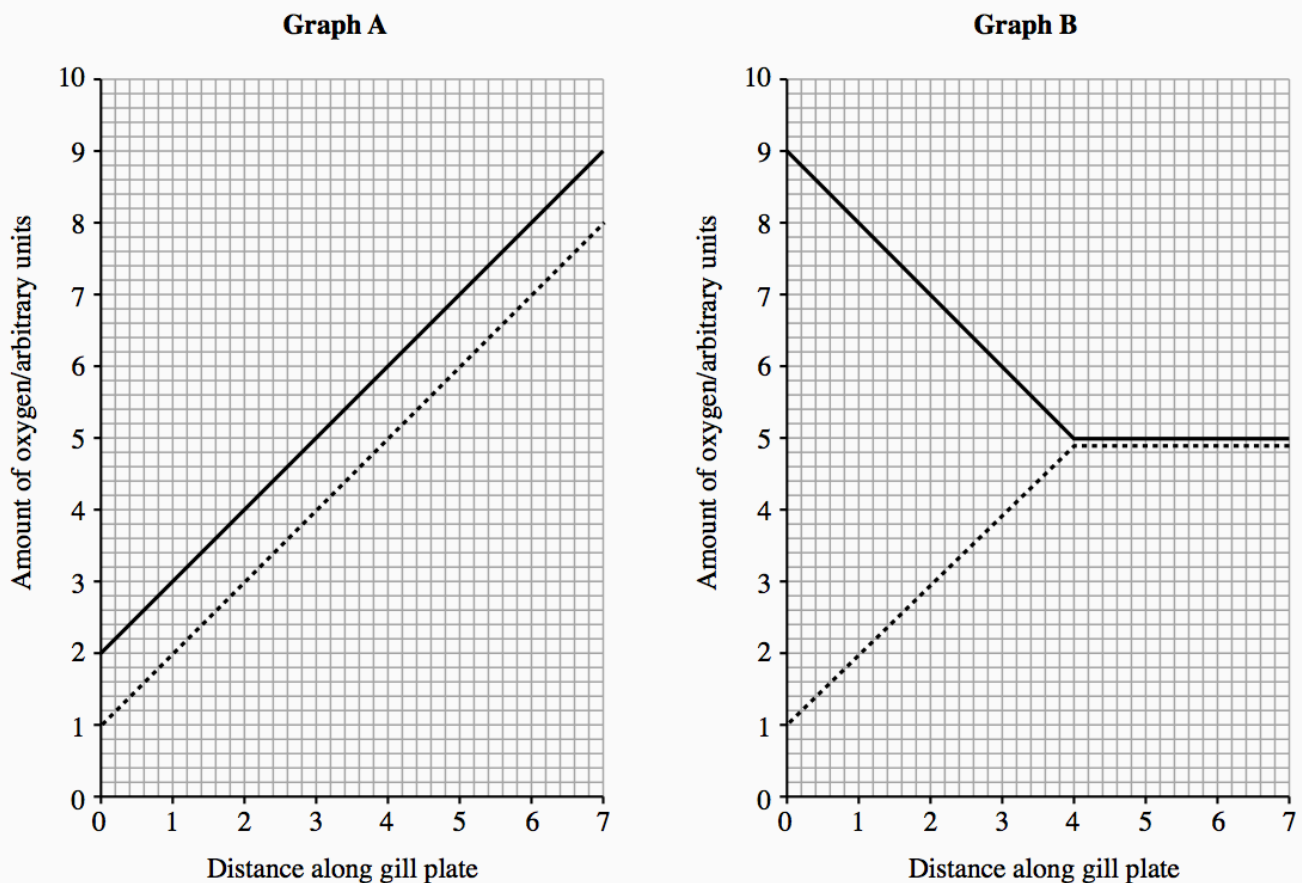
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(Total 5 marks)

16.

- (d) In some fish, water is forced over the gills in the opposite direction to the flow of blood in the gill plates (counter current flow). In others, water and blood flow in the same direction (parallel flow). The graphs below show the relative amounts of oxygen in water and blood as the water moves across the gill plates, for the different types of flow.



Key:

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- (i) Complete the key above to indicate which line shows blood and which shows water. [1]

- (ii) Which graph shows counter current flow? [1]

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- (iii) Use the graphs to put values (in arbitrary units) into the following table: [3]

	<i>Graph A</i>	<i>Graph B</i>
Maximum difference in amount of oxygen, between blood and water.		
The distance along the gill plate over which exchange is possible.		
The maximum amount of oxygen in the blood.		

- (e) (i) Use the information in the table to state which type of flow is the more efficient. [1]

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- (ii) Give **one** reason for your choice. [1]

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(Total 14 marks)

Essays

1.
 - (b) Discuss the main ways in which different animals are adapted to exchange respiratory gases. [10]
2.
 - (b) (i) Describe how organisms such as *Amoeba* and the earthworm are able to obtain oxygen without the need for specialised breathing organs. [5]
 - (ii) Describe how pressure changes are achieved and bring about inspiration in a mammal. [5]
3.
 - (a) Describe how the structure of the leaves of flowering plants is adapted for gaseous exchange and photosynthesis. [10]
4.
 - (b) Describe the **structure** of the leaf of a flowering plant, explaining how this structure is adapted to the functions of the leaf. [10]
5.
 - (a) Discuss the adaptations shown by different terrestrial animals for gas exchange. [10]
6.
 - (b) Explain why large, multi-cellular organisms have evolved special surfaces for gaseous exchange. [3]

Describe and explain how terrestrial mammals are adapted for gaseous exchange in air. [7]
7.
 - (b) Give an illustrated account of the structure and function of stomata in the leaf. Briefly explain the opening mechanism of stomata. [10]
8.
 - (a) Describe how the structure of a leaf is adapted for photosynthesis and gas exchange. [10]